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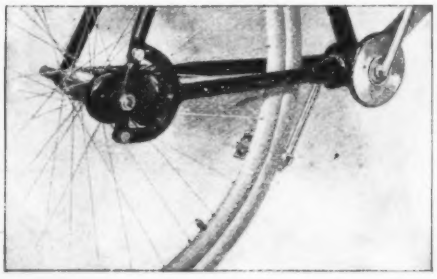
THE COLUMBIA CHAINLESS.

THE AUTHENTIC STORY OF A MARVELOUS ACHIEVEMENT.

By Russell Stone.



The chainless bicycle, be it said in the beginning, has come. The long-promised, long-deferred is here. In that quiet Connecticut capital from whence near a million bicycles have come, through streets whose arching trees were just turning to yellow and gold, I have taken my first ride upon a successful chainless wheel.

The word successful implies much; in the present instance, it implies a marvel. I wish to indicate all of this. The wheel which I rode, one of the earliest made, has been in service about a year; it has had the roughest usage; it has been out in all weathers; it has been subjected to every possible test which a bicycle might ever be expected to undergo. And it runs to-day as easily as any bicycle that was ever put on the road. It has been under test, as I say, for months, and its shaft is not twisted, its bevel gears are not out of plumb, the wheels are not sprung, the cogs are not broken.

In brief, what the greatest of bicycle makers regarded as impossible, what the most competent of mechanical engineers declared was utterly impracticable, what even his own experts looked upon as a foolhardy attempt, the indomitable builder of the famous Columbia has at last achieved.

The wonder of it, if the paradox is allowable, is that nothing wonderful is apparent; it is so extraordinarily simple. Outwardly there is nothing more noticeable than the absence of the awkward and clumsy chain. Inwardly there is nothing more than a pair of bevel gears, set at either end of a short slender steel shaft. All this is boxed in; the metal case which encloses the gearing is but little larger than one of the big cyclometers which were in use a few years ago; the shaft itself turns in a hollow tube no larger than that comprising the frame of an ordinary chain-and-sprocket wheel. And that is all. The entire mechanism occupies so little visible space that, as you look at the machine for the first time, you are at a loss to understand how it runs.

It is just because of this, and because it does run, smoothly, noiselessly and with greater ease than any wheel which has yet been made, of any type, that it is a success.

Note.—These articles on Great Business Enterprises are prepared under the supervision of the editor of the Magazine, by a member of its regular staff, and with the same literary and artistic care as articles designed for the body of the Magazine. The cost of them is borne, however, by the several firms whose industries they describe.

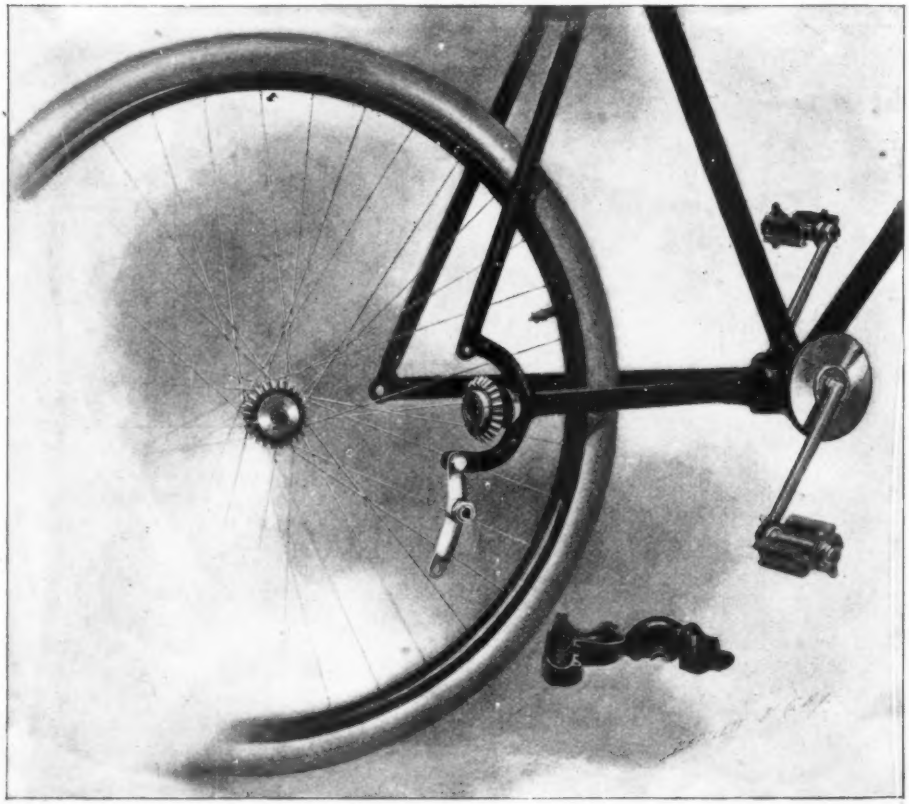
In order to realize the full measure of this achievement it will be necessary to go back a little. For ten years or more rivalry in the field of bicycle construction has been of the keenest. Probably no industry in the world has engaged finer mechanical genius, nor, for that matter, larger capital, proportionately, than has been lavished on the perfected "safety." One must have personally made a tour through one of the great factories and seen with his own eyes the truly marvelous mechanical contrivances, the care and detail which go to the making of the swift, graceful machine we ride, in order to adequately realize what a triumph of constructive ingenuity it is.

And yet there was one unsatisfactory feature. That, it is needless to say, is the chain. It does not require an expert knowledge of dynamics to understand that the chain and sprocket is an expensive device for the transmission of power. As soon as the chain begins to do work, it begins to wear—and fill. It is exposed to the weather, and mud and dust. All these influences directly shorten its life. More than all this, its effect, since it is placed upon one side, with no counter-balancing force, is to pull the rear wheel out of plumb—to twist it round.

Thousands of dollars, hundreds of devices, and endless experiments have hitherto failed to overcome these difficulties or to find out any better substitute.

Among these hundreds of devices the bevel gear and transmitting shaft was one; and one of the most attractive. And for this reason almost every bicycle maker has tried to construct such a gearing—one that would be a success.

Now, not the least remarkable part of the matter is that four or five years ago such a bevel gear and shaft was actually devised—was an actual success. That was the old League wheel. It was a cumbersome machine, its construction was faulty, its tread was very wide, its weight was thirty-eight pounds. It was far from a



SHOWING EASE OF LIFTING OUT REAR WHEEL.

thing of beauty. But a thousand or more of these machines were marketed before the company failed and went out of business.

This wheel was so well liked in spite of all its faults that there is more than one rider in this country who has awaited the construction of a new and better chainless before he would give up the old one. The wheels were suprisingly easy to ride—they even made records. A well-known rider, "Jack Knowles," made sixty consecutive centuries on one of them, and that, too, in sixty consecutive days. Many of his runs were over roads that would have been impassable for an ordinary chain-and-sproket wheel; they were ridden through mud and slush, and with water, at times, almost to the hubs.

All this was not merely extraordinary then; it has never been equaled since by any wheel now on the market. It is notable, too, that whoever rode a League wheel found his initial prejudice giving place to admiration for some of its features. With all the handicap of a bad model and crude workmanship, the League wheels were a demonstration that the bevel gears were built to run.

After the League enterprise failed its patents went into the hands of the Columbia company. As a matter of course League wheels in Hartford and round about began in time to come to the Pope Manufacturing Company's works to be repaired. The vital part of the story is here: *they never came because of any failure of the bevel gears.* Other parts of the machine might go to pieces; the bevel gears were still intact.

All this, it should be noted, was in entire contradiction to what all the experts and trained engineers had invariably declared would take place. The experts were persuaded that the cogs would bind, that the apparatus would crumple up, and, in short, that the bevel-gear principle could not be applied on a bicycle with success.

Any one who has gone even a little way into the history of invention and mechanical advance, especially in this country, will have learned that "impossible" is a dangerous word. The present instance is to be added to other notable cases of such bad usage.

The fact that stood boldly out was that the mechanical demonstration of the chainless bicycle had been made. It was one thing, however, to make a bevel-gear wheel which would run for thousands of miles without appreciably showing wear and tear; it was quite another to make a chainless wheel that could be put on the market at a price which would enable it to compete with the wheel now in vogue. The success of the bevel gear was due to two things: first, fine gear cutting, and second, to a frame so rigid that the gearing could not be dislocated or sprung. The introduction of nickel steel made possible a frame that would be at once sufficiently rigid and still not unsightly or clumsily large. There remained the problem of cutting on a large scale absolutely perfect gears.

It has cost half a million dollars to solve this problem. When the makers of the Columbia began their experiments, two years ago, there were not in the wide world factories with a sufficient capacity to supply the Pope factory with bevel gears for an hour a day.

It was an absolute requisite that these little gears—not so wide as the palm of your hand—should be cut so true that when they came to be put together, or rather, what is much more to the point, when they came to roll together, they would not vary a hair's breadth—not one two-thousandths of an inch! Formerly they were cut by hand, at least such as required this extreme accuracy. In order to make them in sufficient quantities for use in a bicycle, it was necessary that they should be made by machinery, and by the hundreds a day.

The machine to do this has been built and is at work. As you stand watching it it does not seem human—it seems more. With clock-like precision it takes hold of the roughed-out pieces of bevel cogs as they come from the die in which they have been forged, and chisels and pares them down to a fineness of finish comparable only to the movement of the most delicate watch.

It is not merely that these cogs must be cut smooth and true; they must be cut upon a curve and with a shelving face. Not only must the cog be rounded with absolute precision, but the opening between the teeth must be slightly wider toward the upper end. This tapering of the teeth and the spaces must be exactly uniform. More than this, the side of each tooth must be cut with a gradual and mathematically exact swell (what is known as an epicycloidal curve), so that when the teeth are in operation they will come together and separate with a rolling motion and without any slipping or grinding whatever.

Now, imagine, if you will, a machine which, when the roughed-out gear is set in

place, will cut away these teeth of such extraordinary shape—file them down, as it were, to the exact degree of fineness, and, having completed one, turn to the next without any interference from the operator; and so on clear around the circle. Then with a sharp click, like that of a benign old lady snapping together her needles when the stocking is done, this automaton of steel draws back its knives, throws off the belt and thus announces that its appointed task is finished. As I stood before it, marveling greatly, I seemed to understand why it did not look up and speak to me; it was much too busy, and no doubt its voiceless brain was too weary, after such an exacting task, for speech.

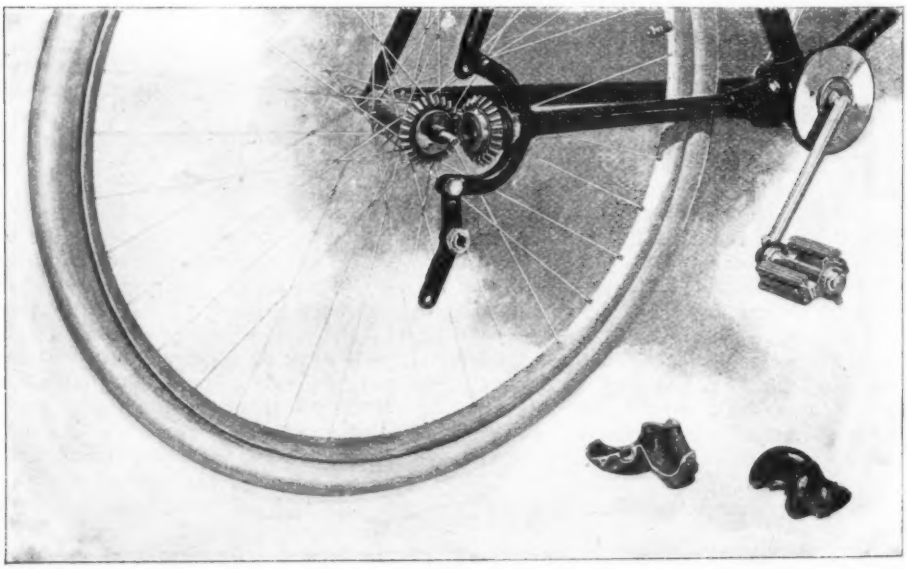
Yet even when these wonderful affairs were designed and completed and set up, row after row, like workmen at a bench, merely a beginning—though it was a very great beginning—had been made. To have mechanically perfect gears that could be cut by machinery in half an hour where it had formerly required days was a great advance. But it was still necessary to construct a frame which should not merely permit of a free working of the parts when first set up, but should hold them together so firmly that they might be subjected to any strain, short of that which would ruin the entire machine. The frame must be so rigid that no strain will draw the gearing apart by so much as the hundredth of an inch. This is one reason why the old League wheel was so heavy. Its makers knew no other way to give it this required firmness than to make it, figuratively, as heavy as a dray.

It was just about this time that the National Government had shown the astonishing possibilities that lay in the use of nickel steel for armor plate. Elaborate tests upon this new metal disclosed that by the addition of a small percentage of nickel, steel takes on a wonderful rigidity without losing those other qualities which have made it the most useful metal in the world.

It was a naval engineer who suggested to Colonel Pope the possibility that nickel steel might be employed in the manufacture of bicycles in the making of frames. At that time there was not a single establishment in existence manufacturing nickel steel tubing; it was not even known that such a tubing could be satisfactorily made.

It has required an outlay of nearly a million dollars to build and equip a plant for this purpose; but the result has justified the expenditure. Nickel steel tubing has been introduced in all the Columbia Bicycles made this year, and it has been found to be the most perfect material for this purpose which has yet been discovered.

It is nickel steel which, as I remarked a little way back, has made possible the construction of light, graceful bevel-gear shafting. A glance at the illustrations which



CAPS REMOVED TO SHOW REAR GEAR IN PLACE.

accompany this article will disclose the principle employed and likewise the method of construction.

Bevel gears join the rear axle and likewise the crank-shaft between the pedals Between these two pairs of gearings is a short, hollow shaft, set upon ball bearings and transmitting the motion of the crank-shaft to the rear wheel. Practically this is all. Delicate devices, which it would be difficult here to describe with profit, unite the shaft with the bevel gears so firmly that they will run for years without disturbance and yet permit the rear gearing to be removed and another substituted with quickness and ease.

It almost goes without saying that a long-headed business man with a reputation which a generation of commercial and mechanical success has established, will not risk either that reputation or the half million dollars he has invested, on a product that offers the slightest possibility of failure when placed before the public. Still, I can give but a faint idea of the long course of experimentation and the exhaustive tests which have wrought the new chainless wheel to probably the highest pitch of perfection which it is possible at this day to achieve.

The fact which should be borne in mind is that the bevel gear has been worked out in the face of what those who were regarded as the highest authorities had to say upon the subject. It is very interesting to learn that even after the thing had been done the experts still declared that it was not commercially practicable. Even the trained engineers persisted in this belief long after the old League wheel had shown that the bevel gear could be made a success. The chainless wheels made by this company had been running in Hartford, and notwithstanding every test for two years before the men who had made the Columbia what it is—the finest-built wheel in the world—could be brought to believe that the new type might be so far perfected as to be superior to the chain-and-sprocket wheel. Such is the force of educated prejudice.

If such a degree of prejudice is to be found among those who have made all these questions more or less of a life-long study, it will not be surprising to find much adverse opinion in the minds of those who are merely bicycle riders. It will be of interest, therefore, to run over one after another of the questions which naturally arise when one comes to consider the chainless for the first time. In doing this we may note what the tests, hundreds upon hundreds in number, have demonstrated. These tests, it may be said in passing, may be regarded as the final word upon the subject, since it is obvious that for the Pope company itself to entertain the slightest delusion regarding the new wheel would result, in the end, in sure and certain disaster.

First, as to the question of efficiencies. It was found that under a heavy load the chainless wheel showed an efficiency of nearly 95 per cent. and under light loads 88.5 per cent. This is not only a higher average than can be obtained with a chain wheel, but it likewise develops the highly important fact that under extremely heavy loads, corresponding to the very worst of hill climbing, the bevel gearing shows none of that "cramping," which was so much feared. It simply did not occur.

It was also noted that where the chain wheel lost in efficiency when a side strain was put upon the crank bracket, similar to that which comes in hill climbing, under the same conditions the chainless wheel lost nothing at all.

Again, it is probable that most people would, at first thought, regard the friction of bevel gearing as greater than that of any other form. This, because of the fact that in the transmission of the motion there are two right-angle turns. As a matter of fact it has been found that, all other things being equal, bevel gearing is slightly more efficient than spur gearing, (of which the chain and sprocket is a combination type).

It has been found that what would be called ordinarily a fairly clean chain is less efficient by 3 or 4 per cent. than the same chain when carefully cleaned and oiled. Such variation of conditions does not exist with the driving mechanism of the chainless, as it is practically perfectly protected from dirt; and this is what no gear case can insure. Further than this, the wear of the chain, with accompanying disagreement of pitch with sprockets, goes on just the same even within the gear case.

The wear upon the gear teeth, cut and carefully hardened as they are, is inappreciable, so that they can be run for many thousands of miles without showing the slightest deterioration.

In the discussion of the chainless bicycle much has been said of the "torsional strain" to which such a shaft as

that employed in bevel gearing would necessarily be subjected. It seems a prevalent idea that no piece of steel could be made sufficiently strong to withstand this strain without being all out of proportion to the rest of the wheel. As a matter of fact, not only has such a shaft been constructed so slender that it rolls within a piece of frame tubing of the ordinary size, but it is so strong that under ordinary strains it actually increases, very slightly, in efficiency, rather than the opposite. This is precisely the reverse of the behavior of the chain wheel under a similar strain.

I may compact into a few brief sentences some other of the disclosures of the tests both on the road and in the shop—tests which have now been carried on for more than a year.

Under all conditions of riding, and under all tests, the chainless runs easier than the chain machine. This is due to the fact that the bevel gear offers less resistance due to friction than the best chain bicycle which can be built. A perfectly-cut bevel gear presents a rolling contact against its mate, producing no more friction than a pair of shafts, or even ball bearings, rolling together.

The frame does not get out of line under the application of pressure, and even if it should do this by any accident, this fact makes no difference with the gearing whatever. Both the shaft and the teeth of the gears are so hard and so strong that the driving cranks will break before they give way. This is the best illustration I can give of the strength of the bevel-gear construction.

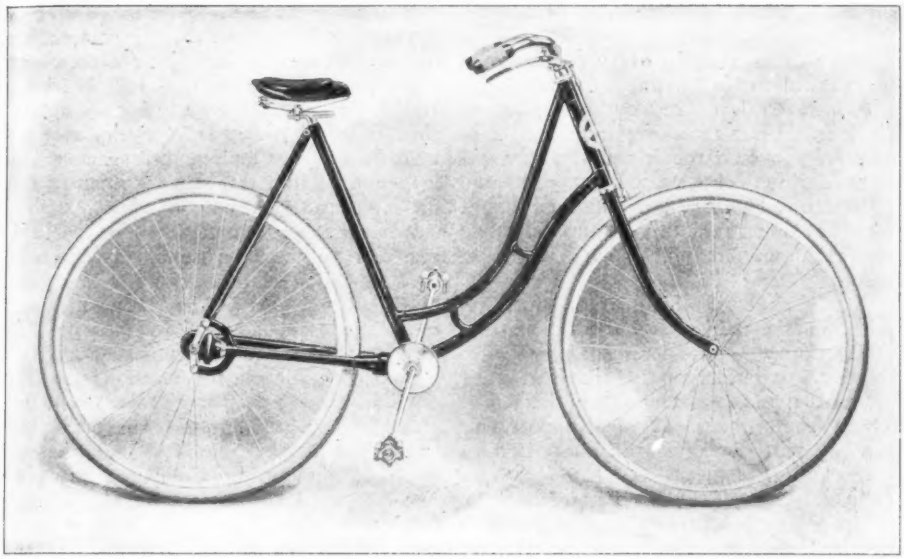
The chainless wheel makes less noise than the chain wheel even when each are new from the factory, and it goes without saying that as the chainless gearing is nowhere exposed to dirt or the atmosphere, and hence undergoes no wear or rust from these influences, it is as noiseless at the end of the year as the day it started.

The driving mechanism of the chainless is, on the whole, less complicated and has a smaller number of parts than the chain machine, and is, therefore, less liable to get out of order. More than this, it requires a skillful hand to take apart the chain-and-sprocket wheel and put it together again properly. The chainless is so simple that no more than ordinary experience with a wheel is required to take it down and put it up.

The difference in the weight of the chain wheel and the chainless, model for model, is so slight as to make no appreciable difference—a matter of no more than two or three pounds.

With the use of nickel steel tubing, and the bracing device to give additional firmness, the Columbia Chainless is the strongest bicycle that has ever been made.

THE COLUMBIA CHAINLESS READY FOR THE ROAD.



THE LADIES' COLUMBIA CHAINLESS.

Finally, it is practically established that the bevel gearing will outlast the other important parts of the machine. In other words, so highly has the new mechanism been developed that it has practically surpassed many other portions of the bicycle. This is to me a very striking fact.

It remains for me to give account of my own sensations on the new wheel. I mount on a street opposite the factory that has a considerable grade and start off up the hill. The sensation afforded by the first stroke of the pedal is an odd one. There is no "give," or yielding as in the chain wheel, at all, but a curious feeling of firmness. At the instant that I apply pressure upon the pedal the machine seems to answer. There is no "back-lash," as riders have come to call it—that slight jog or interval which comes at the moment when one pedal releases the tension and the other takes it up.

More than this, although the chainless is absolutely noiseless and the friction is demonstrably a great deal less than in the type to which I have been accustomed, it seems as if I can yet *feel* the gearing and follow it as it carries the motion of the crank-shaft back to the driving wheel. I cannot better describe this rather elusive impression than to say it seems to add to that exhilaration which every bicycle rider must experience "in making the thing go." It is, I fancy, an added sense of having your machine absolutely under your own control.

I have not been upon my own wheel for perhaps a month, and yet I mount the hill with surprising ease. This is due, I suspect, to the fact which I have already noted—that the stroke is longer and quicker to take effect. The considerable loss of energy which must necessarily occur in taking up the slack of the chain, when passing the "dead point" at each revolution, is completely eliminated.

So, again, when I turn the corner and meet a strong head wind, I experience the same effect. The positive motion of the bevel gears gives one a peculiar sensation of "going straight ahead." There is no feeling of a strain, and momentary pause, and then the answering motion, as in the case of the chain wheel. Similarly in going down hill there is the same impression of absolute control, and hence ability to stop the wheel or slow it as one likes.

Disregarding the municipal regulations of Hartford I put the new wheel to various coasting tests and am rather astonished to find that it moves off with no more feeling of resistance than that of the chain wheel under the best possible conditions. I am told that the most precise tests have shown that the chainless will actually coast farther and run farther when the wheel is lifted

off the ground, than the best of the old type.

Nor is this all. In every century road test the rider of a Columbia Chainless has shown much less fatigue than his companions. Upon returning from a spin of 104 miles over a rough country, an experienced rider, who started out with "no faith in bevel gears" gave this report: "I must say that I rode this distance with less effort than any 100 miles I ever attempted before."

A slight matter which is still worth reporting is this: I rode all about the streets of Hartford upon the chainless wheel without any "trouser clips," and just as I stepped upon the machine from the street. There seems not the slightest opportunity for any part of the machine to catch in your clothes.

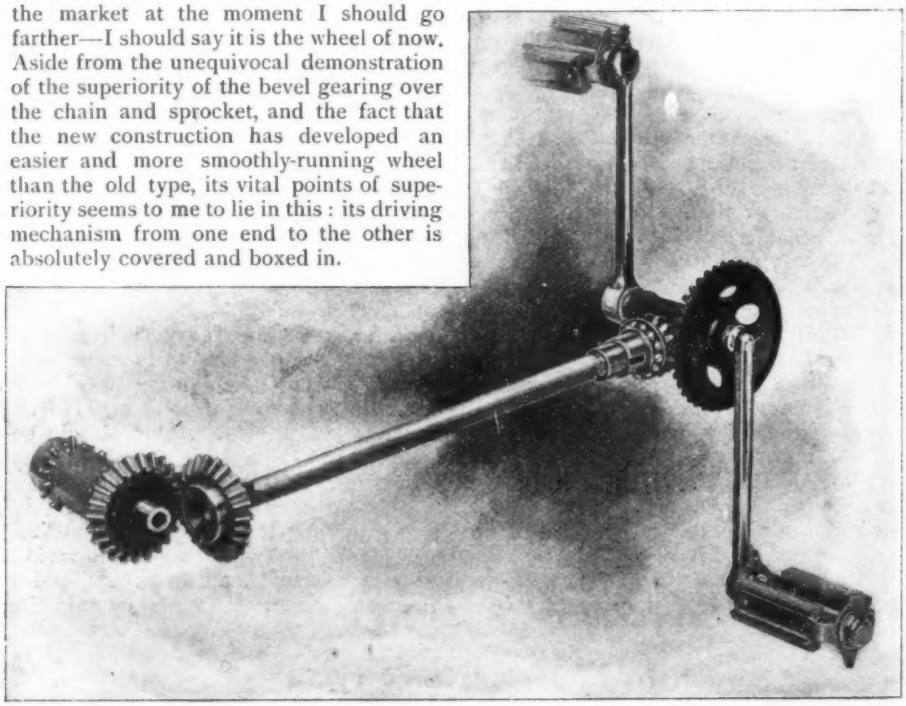
The absence of the chain guard must be inexpressibly welcome to women, for with this comes the assurance that no flapping of skirts will hereafter result in a sometimes perilously sudden and involuntary dismount.

It must be clear from what I have said thus far that my experience with the chainless wheel has left me without a doubt that it is the wheel of the future. Were it on the market at the moment I should go farther—I should say it is the wheel of now. Aside from the unequivocal demonstration of the superiority of the bevel gearing over the chain and sprocket, and the fact that the new construction has developed an easier and more smoothly-running wheel than the old type, its vital points of superiority seems to me to lie in this: its driving mechanism from one end to the other is absolutely covered and boxed in.

The importance of this marked step in advance seems to me exactly comparable to the difference between an enclosed and open crank-shaft, axles and ball bearings. If it is important that these last should be shut in and protected from exposure to weather and dust and mud, it seems to me it is quite as important that the rest of the driving gear should be equally protected.

For the rest, I do not believe that any one can go over the ground as carefully as I have done and not come to the belief that the bevel gear is the simplest, safest, cleanest, most economical, and most durable form of power transmission that has yet been used in bicycle construction; that for come-as-it-may riding it gives a maximum of speed for a minimum of effort; and, lastly, that in the Columbia Chainless the Pope Manufacturing Company has produced a practically perfect wheel. It represents to me the highest achievement of mechanical genius in this field. More could hardly be said.

The cost of construction, and consequently the price at which it must be sold, seems the only possible bar to its universal use.



THE COMPLETE BEVEL-GEAR MECHANISM.